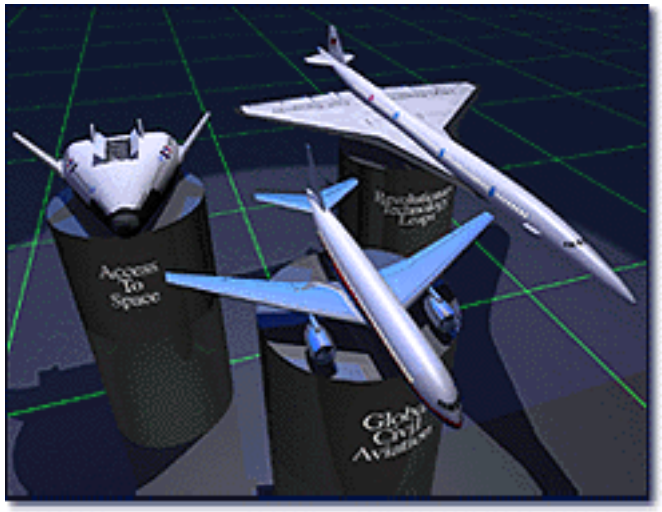


Aeronautics & Space Transportation Technology: Three Pillars for Success

Interdependency of Goals

3rd Workshop on NASA's Environmental Compatibility Research
Monterey, CA
July 8, 1998

Howard L. Wesoky
Team Leader
Environmental Compatibility Assessment

Three Pillars for Success

Message from the NASA Administrator

The goals that follow are dramatic—they are pre-competitive research endeavors in long-term, high-risk, high-payoff technologies. I emphasize the NASA role in these terms because the Government must look to the future in pivotal areas that our private sector cannot afford to address due to the sheer scale, risk, and duration of the task. Industry's responsibility is to maintain their near-term competitiveness through evolutionary advancements to their products. NASA's responsibility is to provide revolutionary advancements that protect U.S. leadership for future generations. The impact of NASA's research on our national air transportation system, our national security, the environment, and our economy demonstrates a clear government role in support of the public good.

Daniel S. Goldin

March 1997

The Market for New Airplanes

Worldwide demand for commercial airplanes,

1998–2017:

The total market potential for new commercial airplanes is 17,650 airplanes, or an equivalent $1.25 trillion in 1997 US dollars.

1997 Year-End Review & Forecast - An Analysis

U.S. aerospace sales will rise for the second straight year as companies take advantage of opportunities in the commercial aircraft and space markets. This **growth is being driven by exports**, which will surge to record levels in 1997. **Employment and labor hours will also be higher** in response to accelerated production schedules. At the same time, industry orders and net profit will be lower. The outlook for 1998 suggests that industry sales will hit a record as commercial gains offset a relatively weak market for products and services sold to the U.S. government. Overall, the aerospace market is shifting from a government-dominated market to one driven primarily by commercial customers. . . . **Sales of civil aircraft, engines, and parts are expected to climb by almost $12 billion to $38.6 billion this year--the largest annual increase ever recorded in this product category.**

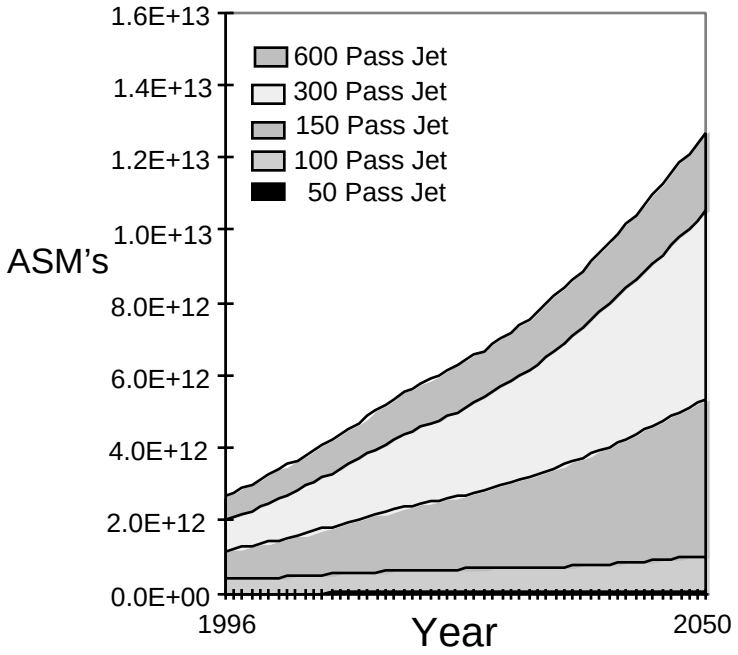
Trade Balance

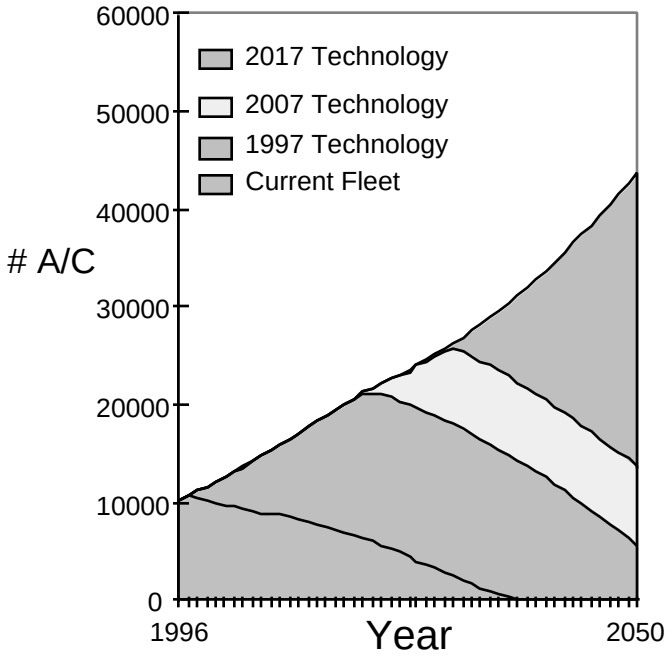
Global trade is now the engine driving the U.S. aerospace industry. U.S. aerospace exports are estimated to reach $50.3 billion and account for 39% of aerospace sales in 1997. Imports will total $16.2 billion. Both export and import levels will be records. **These totals translate into a positive trade balance of $34 billion.**

Commercial transport deliveries will account for most of the export gain. Foreign orders represent 54% of industry's commercial transport backlog by dollar value as of September 1997.

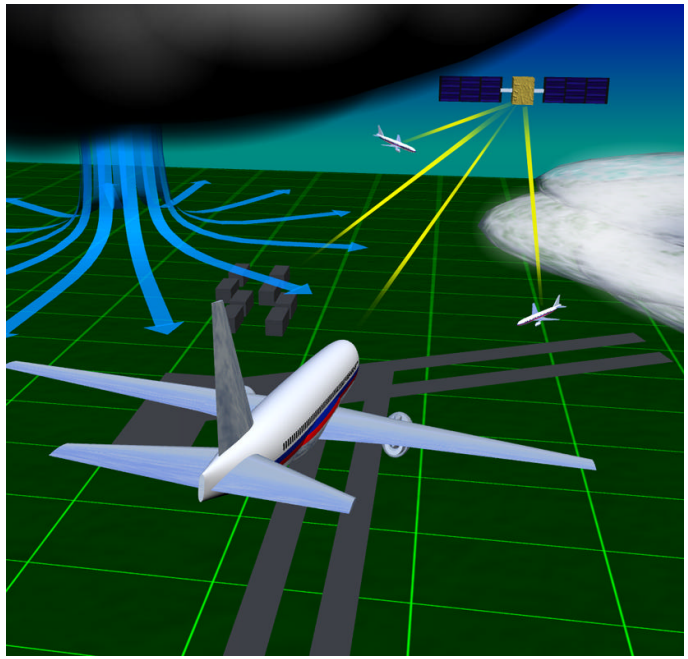
Long Term Scenario

Ref: M. Guynn, May 1998





Pillar One: Global Civil Aviation Enabling Technology Goals



Seamless integration of air travel into the fabric of society: easily accessible, easily utilized, safe, affordable travel with minimal environmental impact. Customer demands will drive air travel systems, service, and products.

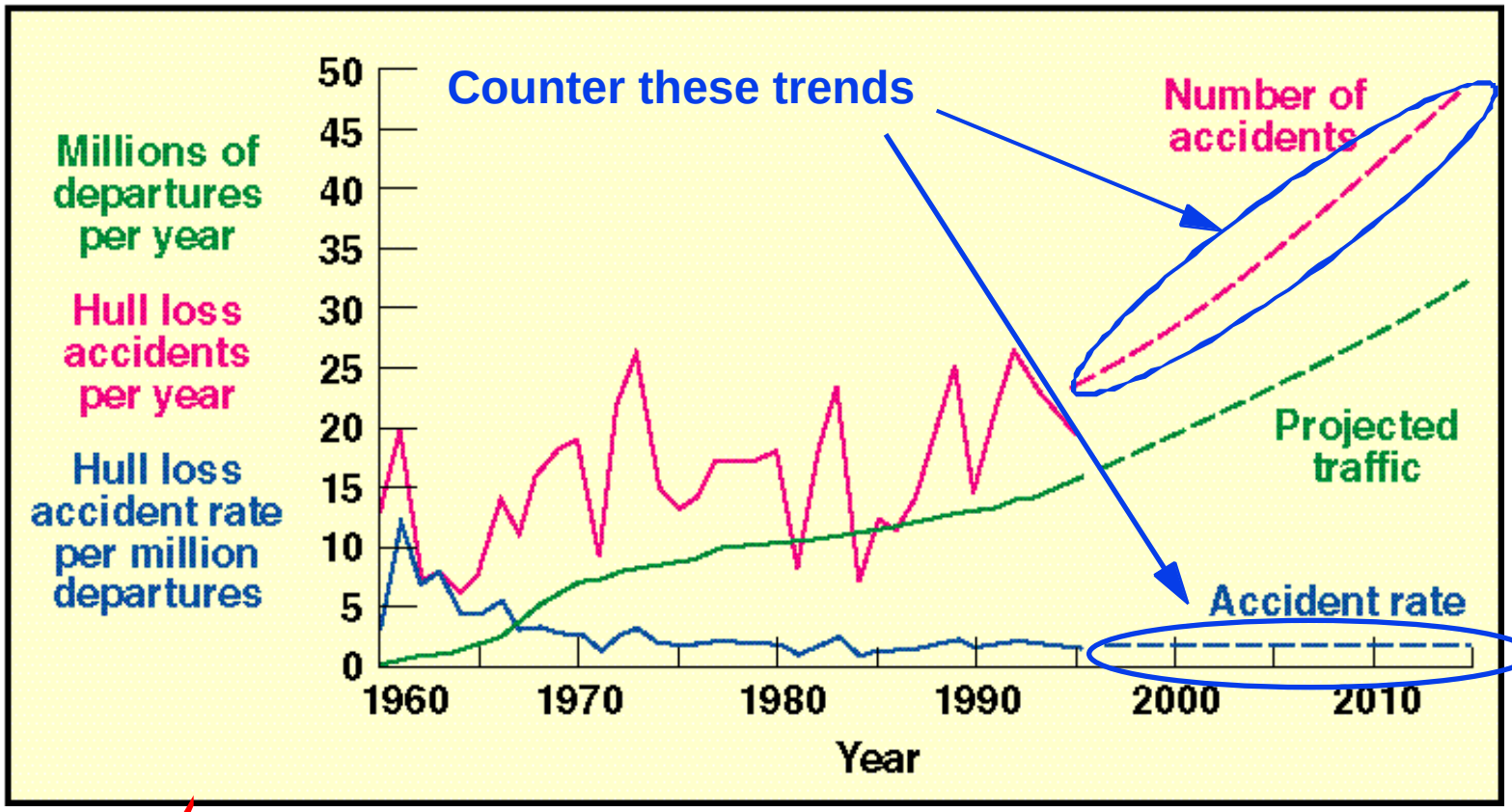
- **Reduce the aircraft accident rate by a factor of five within 10 years, and by a factor of 10 within 20 years**
- **Reduce emissions of future aircraft by a factor of three within 10 years, and by a factor of five within 20 years**
- **Reduce the perceived noise levels of future aircraft by a factor of two from today's subsonic aircraft within 10 years, and by a factor of four within 20 years**
- **While maintaining safety, triple the aviation system throughput, in all weather conditions, within 10 years**
- **Reduce the cost of air travel by 25% within 10 years, and by 50% within 20 years**

Pillar Two: Revolutionary Technology Leaps - Enabling Technology Goals

Research to revolutionize air travel; environmentally friendly transoceanic supersonic flights; technology to dramatically improve small aircraft designs, engines, and overall affordability.

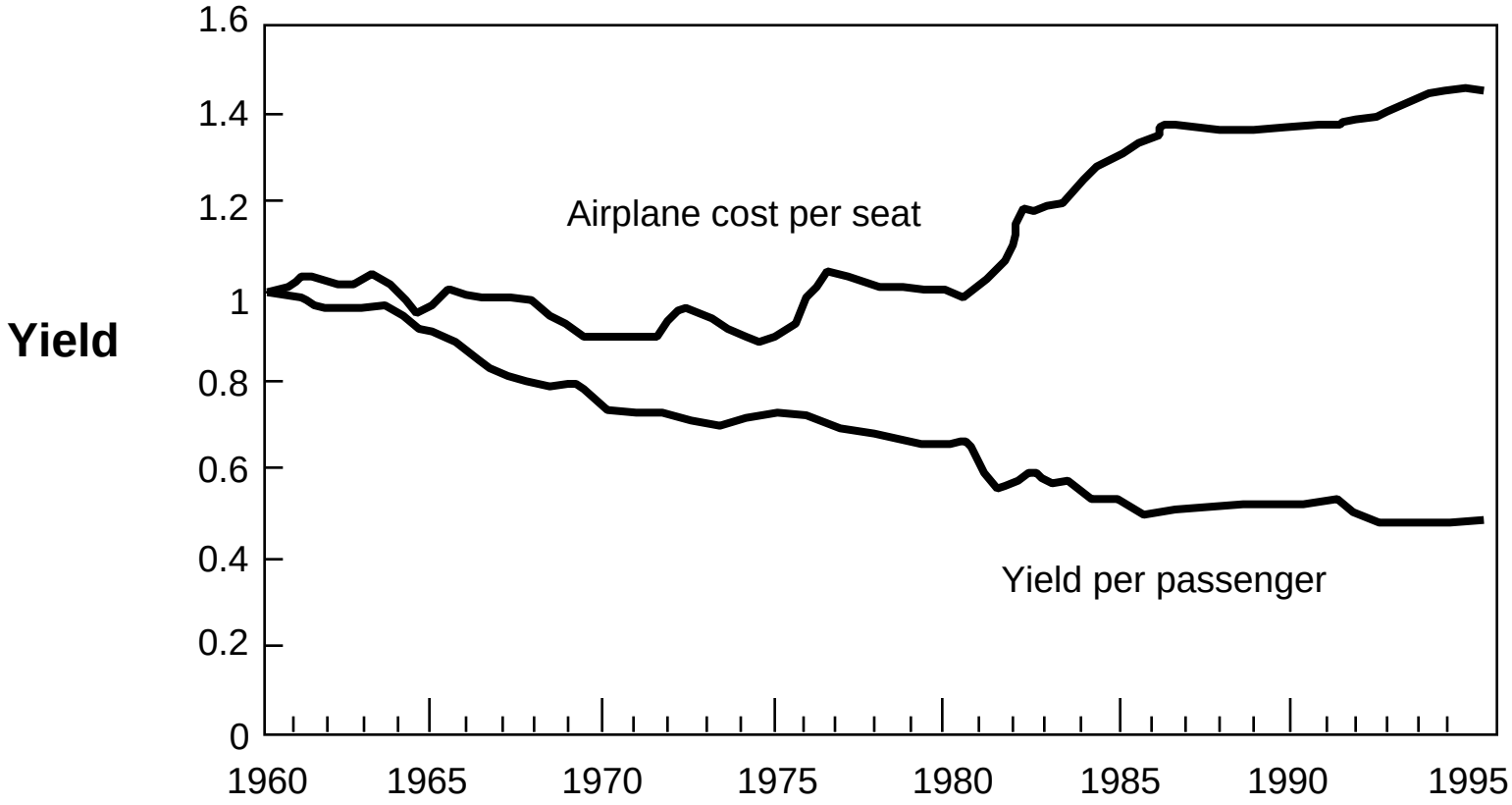
- **Reduce the travel time to the Far East and Europe by 50 percent within 20 years, and do so at today's subsonic ticket prices.**
- **Invigorate the general aviation industry, delivering 10,000 aircraft annually within 10 years, and 20,000 aircraft annually within 20 years.**
- **Provide next generation design tools and experimental aircraft to increase design confidence, and cut the development cycle time for aircraft in half.**

Safety Goal Benefits



- **Save 1,000's of lives**
- **Allow full growth of aviation market without limits due to safety concerns**

Yield Per Passenger Versus Price Per Seat



Condit, P., Performance, Process, and Value: Commercial Aircraft Design in the 21st Century, 1996 Wright Brothers Lectureship in Aeronautics, World Aviation Congress, American Institute of Aeronautics and Astronautics, October 1996.

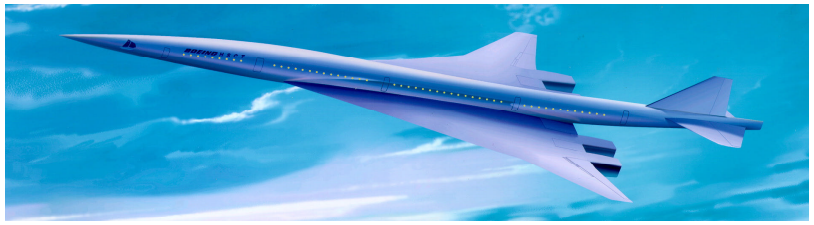
CNS/ATM Emissions Benefit

Annual Savings in Millions of Pounds, Year 2015

	Fuel	NOx	CO	HC
Above 3,000 ft	9,683	204.3	197.1	56.7
Below 3,000 ft	219	4.0	1.1	0.1
Surface	358	1.2	13.2	3.1
Total	10,259	209.5	211.4	59.9
% Savings	6.1%	9.9%	12.7%	18.0%

Ref: D. Liang, FAA, 5/98

High-Speed Travel Benefit



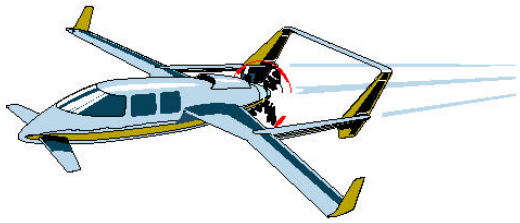
- Potential for 140,000 new jobs and $450B swing of trade balance
  (An offshore HSCT could result in 160,000 lost jobs)

- Protects US World leadership for long haul transports

- Provides 2 times productivity of an equivalent 300 passenger subsonic transport
  - Improves passenger travel time by more than 2 times
  - Twice as many round trips for a city pair or twice the range (w/service stop) for given block time to improve airline efficiency and asset deployment (800 HSCT's do the job of 1400 subsonics)

Issues	***Technology Leverage***
➤ Emissions	➤ Economically-efficient airframes
➤ Noise	➤ Environmentally-compatible propulsion systems
➤ Vehicle Economics	➤ Reliable avionics, controls, systems for advanced operations
➤ Operations	

General Aviation Benefit

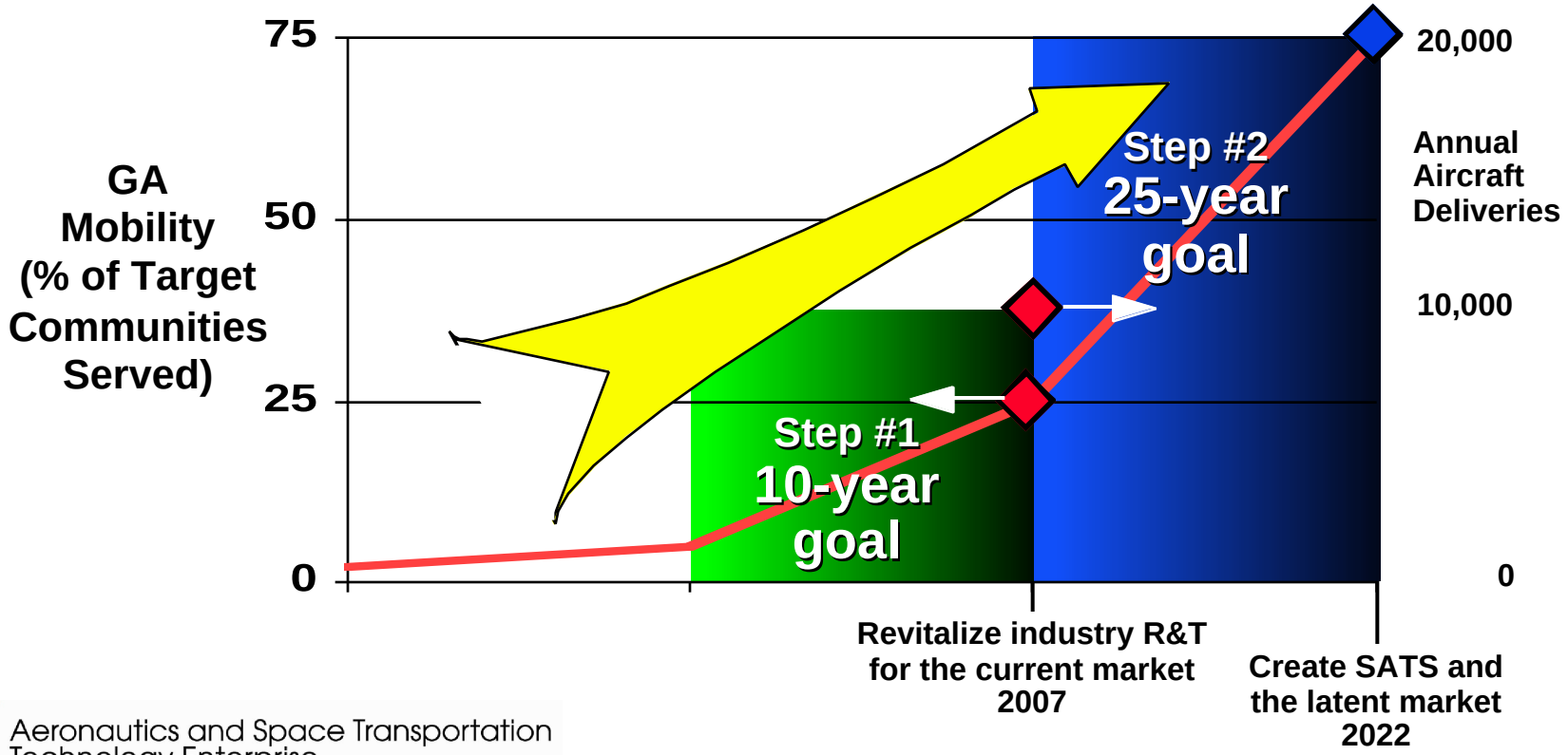


Step #2

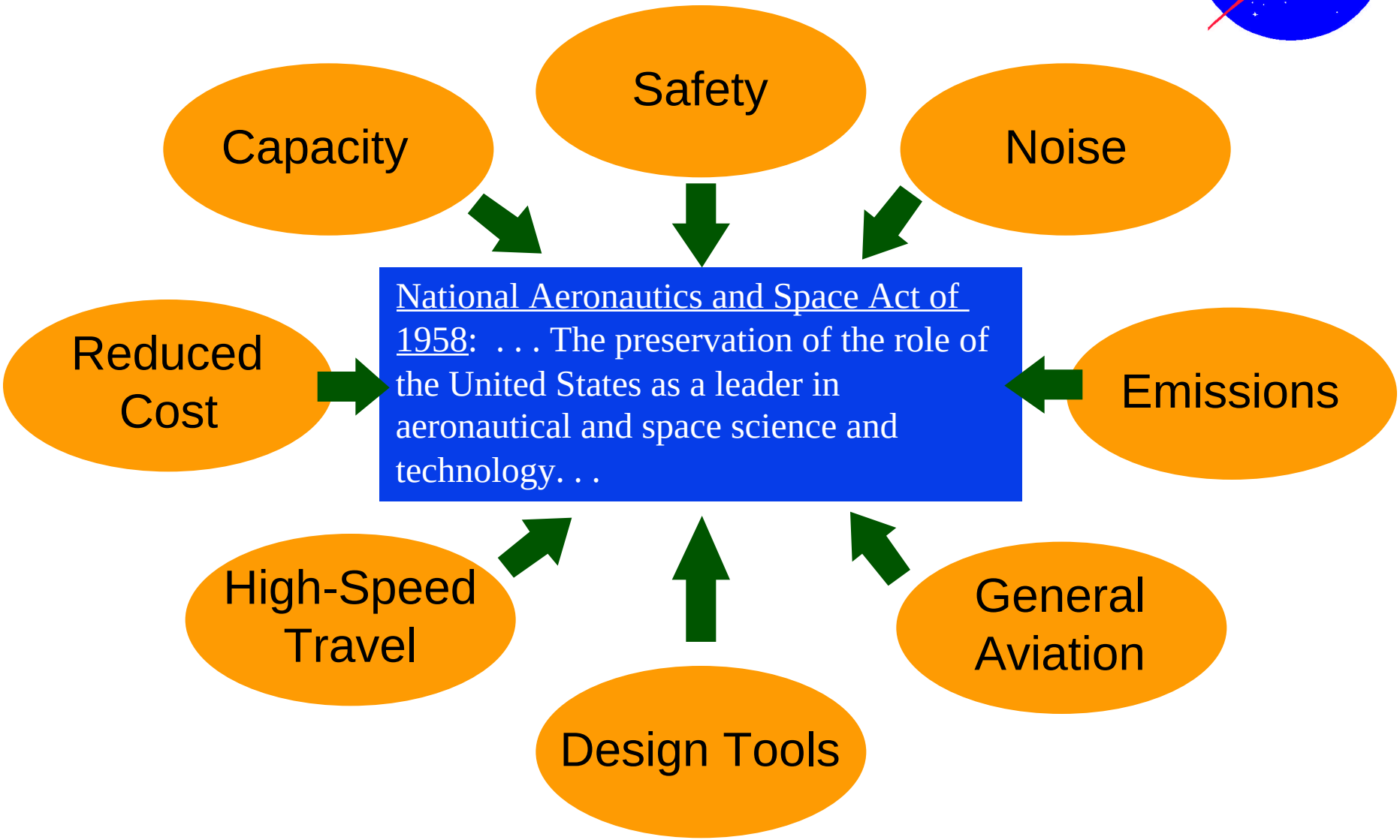
"Stimulate dramatically expanded mobility through Small Aircraft Transportation Systems (SATS) technologies, to serve 25% of suburban, ex-urban, rural, and remote communities in 10 years and 100% of those communities in 25 years."

Step #1

"Invigorate the General Aviation Industry *R&T capacity* for achieving 10,000 new aircraft deliveries per year in 10 years, and 20,000 per year in 20 years"



"Three Pillars" Goals Interdependency



Air Transportation Roadmap

Achieve dramatic improvements in aviation safety, system efficiency and environmental sustainability unattainable through evolutionary improvement

Achieve a new plateau in the transportation mobility offered by aviation at the local, national and global levels to support the transportation needs of a new century

2007

2022

Dramatically reduce major accident causes

Transition to Free Flight Architecture

Achieve major safety, system efficiency and reliability gains through intelligent vehicle-infrastructure systems

Introduce revolutionary systems to provide new levels of transportation mobility
i.e., high-speed transoceanic, regional GA/SATS, etc.

Achieve major advances in mobility through multi-modal, integrated vehicle - infrastructure design & optimization

Sustainable, 21st Century Air Transportation

Dramatically reduce vehicle noise & emissions while improving vehicle efficiency

Develop efficient, cost-effective non-hydrocarbon based propulsion